Modelling and Forecasting Daily Confirmed Cases of Covid-19 in Africa: A Case Study of ECOWAS Countries.

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Abstract
A critical investigation into the rate of spread of Coronavirus Disease 2019 (COVID-19) pandemic has shown that, the daily confirmed cases of the disease tend to follow an upward trend. This paper aimed to develop a suitable Autoregressive Integrated Moving Average (ARIMA) model which can be used to statistically forecast the actual number of confirmed cases of COVID-19 recorded in ECOWAS as a whole. An adequate subset ARIMA (5, 1, 1) model is fitted and discussed. A forecast of 235 days from 11th May 2020 to 31st December 2020, was carried out using the fitted model, and we discovered that the COVID-19 daily confirmed cases may most likely incline over the next six months.

Keywords: *ARIMA COVID-19 Forecast, Time Series.*

INTRODUCTION

Coronavirus disease 2019 (COVID-19) an illness caused by novel coronavirus now called Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) which was first identified amid an outbreak of respiratory illness cases in Wuhan City, Hubei Provence, China, have grown to become a major challenge to the world as more than 200 countries have recorded cases of the disease (WHO, 2020). The World Health Organisation (WHO) on March 11, 2020, has declared the novel coronavirus disease (COVID-19) as a pandemic, as the virus moved from China to almost every part of the world now, with the number of cases as at May 5, 2020 of about four million, one hundred and seventy-eight thousand, and ninety-seven (4,178,097), with about two hundred and eighty-three thousand, seven hundred and thirty-two (283,732) deaths recorded worldwide (Johns Hopkins University, May 2020).
In the Economic Community of West African States (ECOWAS) which includes: Benin, Burkina Faso, Cabo Verde, Core D'Ivoire, Gambia, Ghana, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone and Togo, the story is not different as the number of confirmed cases of COVID-19 is on a rapid increase by the day. As at 10th May 2020, the total number of confirmed cases of COVID-19 in ECOWAS was about fifteen thousand, six hundred and ninety-one thousand persons (15,691), with an average of three hundred and eight cases per day, while the total number of deaths recorded was about three hundred and seventy-three (373) cases, with an average of twenty-eight deaths per day, in ECOWAS countries. (Johns Hopkins University, 2020).
This paper aims to fit a suitable Autoregressive Integrated Moving Average (ARIMA) model for the total daily confirmed cases as of COVID-19 in ECOWAS as a whole.

LITERATURE REVIEW

Several types of ARIMA models have been proposed by different scholar over the years. The Autoregressive Moving Average (ARMA) approach was introduced by Box and Jenkins. (1970) 1976, in their work on Time series analysis: forecasting and control. This approach is

well tested and efficaciously applied by many scholars. For instance, Masukawa, Moriwaki, Uchimura, Menezes, and Uchimura, (2014) studied the impact of the introduction of a rotavirus vaccine on rates of hospitalization of children less than 5 years old for acute diarrhea.
Michael et al. (2004) studied the impact of illicit drug supply reduction on health and social outcomes: the heroin shortage in the Australian Capital Territory. They observed that a sustainable decline in the supply of heroin, as measured by indicators such as drug purity, is related to changes in drug-related health indicator such as ambulance callouts to heroin overdoses. Mishra P. et al. (2013), carried out a work on instability and forecasting using Box-Jenkin's ARIMA model in area, production and productivity of onion in India. In their work they realised that onion is a bulbous spice crop which is produced and consumed largely in India as well as in the world. It has numerous medicinal uses for treating diseases. Amongst the onion producing countries in the world, India ranks second in area and production, the first being China. Onion showed high instability in period II in area, production and productivity. The study also focuses on forecasting the cultivated area and production of onion in India using Autoregressive Integrated Moving Average (ARIMA) model. They fitted an ARIMA (1, 1, 4) model to the data on onion production in India and sued this fitted model to forecast onion production for the year 2020 to be about 23.02 million tonnes

In further studies, ARIMA models have been fitted to economic variable. For instance, Abonazel and Abd-Elftah, (2019), used ARIMA models to forecast Egyptian GDP. In their work, they used Box-Jenkins approach to build the appropriate autoregressive-integrated moving average (ARIMA) model for the Egyptian annual GDP data from 1965 to 2016 which was obtained from World-Bank. They discovered that the appropriate statistical model for Egyptian GDP was ARIMA (1, 2, 1). Finally, they used the fitted ARIMA model to forecast the GDP of Egypt for the next ten years. Nwuju and Lekara-Bayo. (2019), used Box-Jenkins ARMA model in their work on intervention analysis of daily South African Rand/Nigerian Naira exchange rates. In their work they carried out a time series plot of a realization of daily exchange rates of South African Rand and Nigerian Naira from April 2017 to December, 2017 which showed the occurrence of an intervention on 4th August, 2017. They fitted an ARMA (12, 2) model to their data and concluded that management of these exchange rates may be made on the basis of their proposed model. Etuk, Attoe, and Essi, (2012) proposed a seasonal Box-Jenkins Model for Nigerian Inflation rate series. They obtained a seasonal difference as well as a non-sessional difference. The correlogram of the differenced series they obtained, revealed a seasonal nature. It also revealed a seasonal autoregressive component. They fitted an $(5, 1, 0)(0\ 1, 1)_{12}$ seasonal model which was shown to be adequate for the data studied.

2. Materials and Method

2.1 Data

The data used in this work are of secondary sources. The data analyzed in this work are daily sum of cases and deaths recorded from COVID-19 in ECOWAS as a whole from 21st March, 2020 to 10th May, 2020. These were obtained from European Centre for Disease Prevention and Control (ECDC). The used data is listed in the appendix.

2.2. ARIMA Modelling

Autoregressive Moving-Average (ARMA) Model

A time series $\{X_t\}$ is said to follow an autoregressive moving-average process of order p and q, i.e ARMA (p, q), process if:

$$X_t = c + \alpha_1 X_{t-1} + \alpha_1 X_{t-2} + \ldots + \alpha_p X_{t-p} + \varepsilon_t - \theta_1 \varepsilon_{t-1} - \theta_2 \varepsilon_{t-2} - \ldots - \theta_q \varepsilon_{t-q}. \quad 1$$

In summation form we have

$$X_t = \sum_{k=1}^{p} \alpha_k X_{t-k} - \sum_{k=1}^{q} \theta_k \varepsilon_{t-k} + \varepsilon_t + c \qquad 2$$

That ARMA models can be extended to non-stationary series by allowing the differencing of the data series resulting to $ARIMA(p, d, q)$: where with three parameters; p is the order of autoregressive, d is the degree of differencing, and q is the order of moving-average.
Thus an $ARIMA(p, d, q)$ model is given by:

$$\nabla^d X_t = \alpha_1 \nabla^d X_{t-1} + \alpha_2 \nabla^d X_{t-2} + \ldots + \alpha_p \nabla^d X_{t-p} + \varepsilon_t + \beta_1 \varepsilon_{t-1} + \beta_2 \varepsilon_{t-2} + \beta_p \varepsilon_{t-p} \qquad 3$$

where $\{\varepsilon_t\}$ is the error term in the equation; a white noise process, a sequence of independently and identically distributed (iid) random variables with $E(\varepsilon_t) = 0$ and $var(\varepsilon t) = \sigma^2$; i.e. $\varepsilon_t \sim iid\ N(0, \sigma^2)$, and the α's β's and are the model parameters.
The autoregressive (AR) order may be determined by the lap at which the partial autocorrelation function (PACF) cuts off. The moving average (MA) order may be estimated as the lap at which the autocorrelation function (ACF) cuts oft. Estimation of α's and β's may be done by the method of lest squares.

1.3 Box0Jenkins Modelling Selection Approach

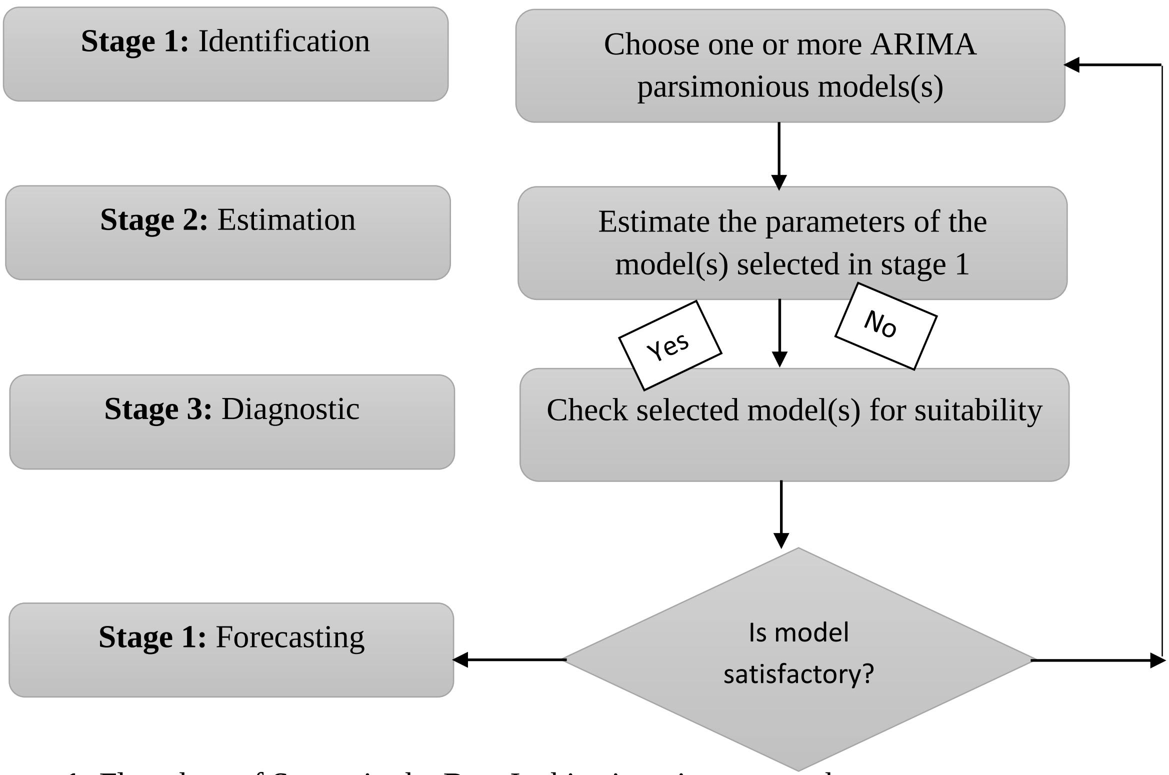


Figure 1: Flowchart of Stages in the Box-Jenkins iterative approach.
All plots and numerical computations will be carried out using E-views version 10 on a Windows10 personal.

4. Results and Discussion

The time plot of the realization of the time series used in this work is shown in Figure 1. This plot shows that the number of daily confirmed cases of COVID-19 in ECOWAS countries, follows an irregular sig-sag pattern showing both upward and download movement over 51 days. They are adjudged stationary by the Augmented Dickey Fuller Test (See Table 1 & Table

2). From the estimation of parsimonious models in Table 3, ARIMA (5, 1, 1) was selected to be the best fit model and it was used to carry out future forecast of the sum of daily confirmed cases of COVID-19 in ECOWAS from May 6th to December 31st 2020.

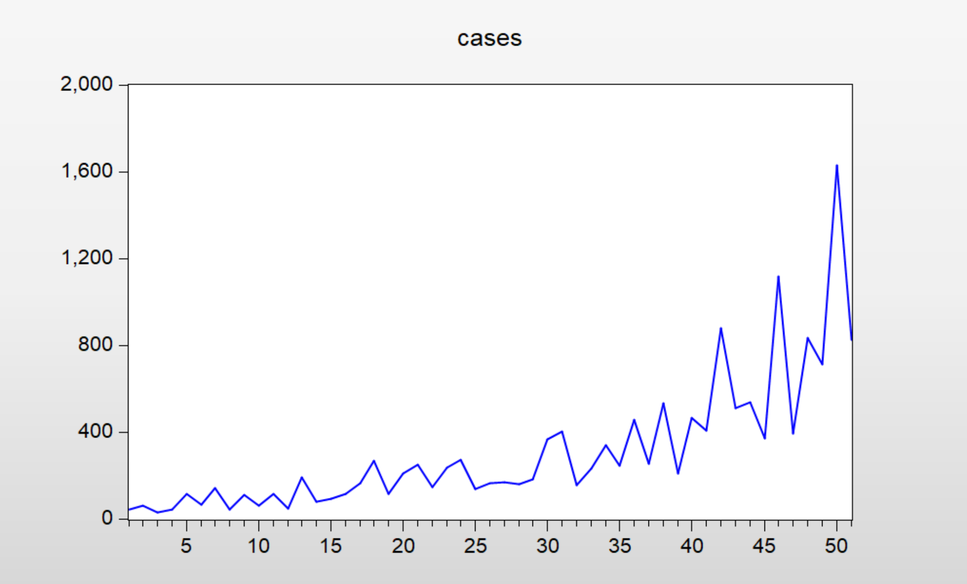


Figure 1: Time plot of daily sum of the actual cases of Covid-19 in ECOWAS States for a period of 51 days.

Table 1: Augmented Dickey-Fuller Test Result of the Actual data showing the nonstationary behaviour of the data.

Null Hypothesis: CASES has a unit root
Exogenous: Constant
Lag Length: 3 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		3.624933	1.0000
Test critical values:	1% level	-3.577723	
	5% level	-2.925169	
	10% level	-2.600658	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(CASES)
Method: Least Squares
Date: 05/11/20 Time: 14:33
Sample (adjusted): 5 51
Included observations: 47 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CASES(-1)	0.372807	0.102845	3.624933	0.0008
D(CASES(-1))	-1.273229	0.157345	-8.091966	0.0000
D(CASES(-2))	-1.012858	0.184220	-5.498096	0.0000

D(CASES(-3))	-1.005176	0.138733	-7.245382	0.0000
C	-26.00656	32.78820	-0.793168	0.4321

R-squared	0.807603	Mean dependent var	16.57447
Adjusted R-squared	0.789279	S.D. dependent var	286.7381
S.E. of regression	131.6253	Akaike info criterion	12.69808
Sum squared resid	727659.1	Schwarz criterion	12.89491
Log likelihood	-293.4050	Hannan-Quinn criter.	12.77215
F-statistic	44.07452	Durbin-Watson stat	1.878863
Prob(F-statistic)	0.000000		

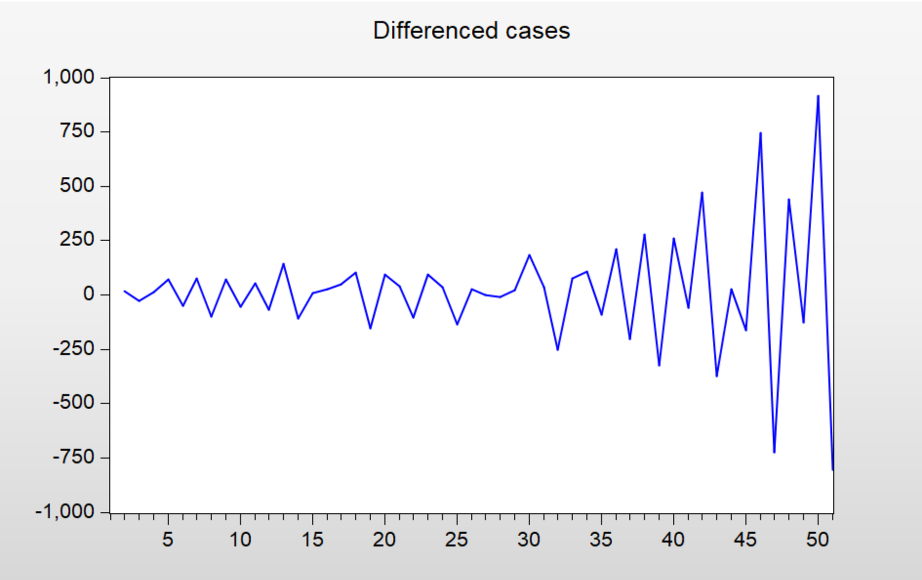


Figure 2: Time plot of the 1st difference total confirmed cases data.

Table 2: Augmented Dickey-Fuller Test Result of differenced data showing a stationary behaviour.

Null Hypothesis: D(LOGCASE) has a unit root
Exogenous: Constant
Lag Length: 2 (Automatic - based on SIC, maxlag=10)

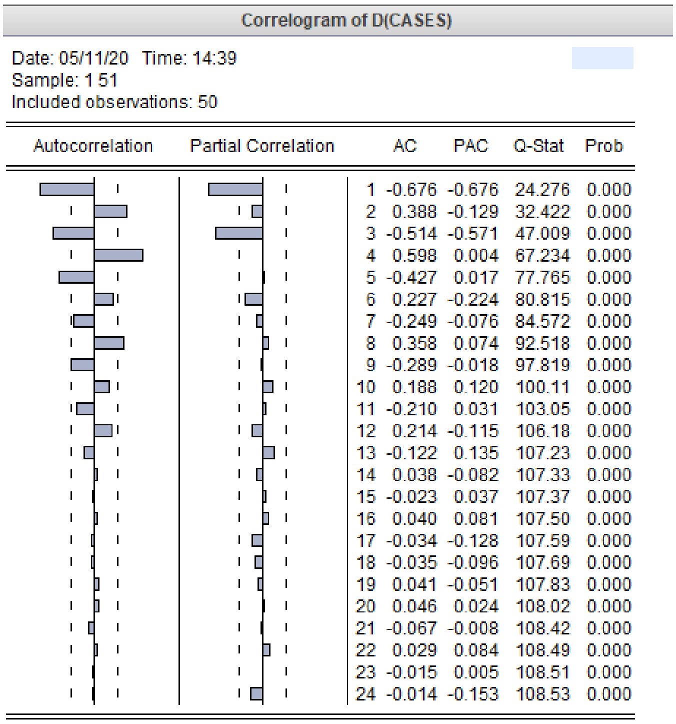
		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.837236	0.0000
Test critical values:	1% level	-3.577723	
	5% level	-2.925169	
	10% level	-2.600658	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LOGCASE,2)
Method: Least Squares
Date: 05/11/20 Time: 14:35
Sample (adjusted): 5 51
Included observations: 47 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOGCASE(-1))	-2.987408	0.381181	-7.837236	0.0000
D(LOGCASE(-1),2)	1.006529	0.291509	3.452823	0.0013
D(LOGCASE(-2),2)	0.417352	0.138354	3.016551	0.0043
C	0.203222	0.067139	3.026864	0.0042

R-squared	0.889697	Mean dependent var	-0.022676
Adjusted R-squared	0.882002	S.D. dependent var	1.246114
S.E. of regression	0.428051	Akaike info criterion	1.222116
Sum squared resid	7.878783	Schwarz criterion	1.379575
Log likelihood	-24.71972	Hannan-Quinn criter.	1.281369
F-statistic	115.6123	Durbin-Watson stat	1.947444
Prob(F-statistic)	0.000000		


Correlogram of D(CASES)

Date: 05/11/20 Time: 14:39
Sample: 1 51
Included observations: 50

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.676	-0.676	24.276	0.000
		2	0.388	-0.129	32.422	0.000
		3	-0.514	-0.571	47.009	0.000
		4	0.598	0.004	67.234	0.000
		5	-0.427	0.017	77.765	0.000
		6	0.227	-0.224	80.815	0.000
		7	-0.249	-0.076	84.572	0.000
		8	0.358	0.074	92.518	0.000
		9	-0.289	-0.018	97.819	0.000
		10	0.188	0.120	100.11	0.000
		11	-0.210	0.031	103.05	0.000
		12	0.214	-0.115	106.18	0.000
		13	-0.122	0.135	107.23	0.000
		14	0.038	-0.082	107.33	0.000
		15	-0.023	0.037	107.37	0.000
		16	0.040	0.081	107.50	0.000
		17	-0.034	-0.128	107.59	0.000
		18	-0.035	-0.096	107.69	0.000
		19	0.041	-0.051	107.83	0.000
		20	0.046	0.024	108.02	0.000
		21	-0.067	-0.008	108.42	0.000
		22	0.029	0.084	108.49	0.000
		23	-0.015	0.005	108.51	0.000
		24	-0.014	-0.153	108.53	0.000

Figure 3: Correlogram of 1st difference of the actual data.

Table 3: Estimation of parsimonious models from the correlogram showing some significant models.

Dependent Variable: CASES
Method: ARMA Maximum Likelihood (OPG - BHHH)
Date: 05/11/20 Time: 14:47
Sample: 1 51
Included observations: 51
Convergence achieved after 427 iterations
Coefficient covariance computed using outer product of gradients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	847.0849	939.9242	0.901227	0.3727
AR(1)	1.244233	0.103992	11.96474	0.0014
AR(2)	0.138427	0.265774	0.520847	0.6053
AR(3)	-0.002403	0.272712	-0.008810	0.9930
AR(4)	0.811349	0.151398	5.359051	0.0000
AR(5)	-0.245029	0.107954	-2.269749	0.0001
AR(8)	-0.065950	0.150028	-0.439585	0.6625
MA(1)	-0.980598	0.325502	-3.012570	0.0157
MA(3)	-0.322258	6.016099	-0.053566	0.9575
SIGMASQ	16572.11	16451.63	1.007323	0.3197

R-squared	0.821859	Mean dependent var	307.6667
Adjusted R-squared	0.782755	S.D. dependent var	308.0400
S.E. of regression	143.5761	Akaike info criterion	13.13888

Sum squared resid	845177.5	Schwarz criterion	13.51767
Log likelihood	-325.0415	Hannan-Quinn criter.	13.28363
F-statistic	21.01721	Durbin-Watson stat	1.967714
Prob(F-statistic)	0.000000		

Inverted AR Roots	1.00+.04i	1.00-.04i	.17-.42i	.17+.42i
	-.04-.93i	-.04+.93i	-.39	-.97
Inverted MA Roots	1.00	-.16-.54i	-.16+.54i	

ARIMA (5, 1, 1) was chosen as the best fitted model.

The equation representing the model is:

$$\nabla X_t = 1.244233 \nabla X_{t-1} - 0.245029 \nabla X_{t-5} - 0.980598 \varepsilon_{t-1} + \varepsilon_t \qquad 4$$

Future forecast for 234 (May 11, 2020 to December 31, 2020) days was carried out using the on E-views using the model in (4) above.
This was achieved by entering the command
ls casesf c @trend @expand(@month, @dropfirst)

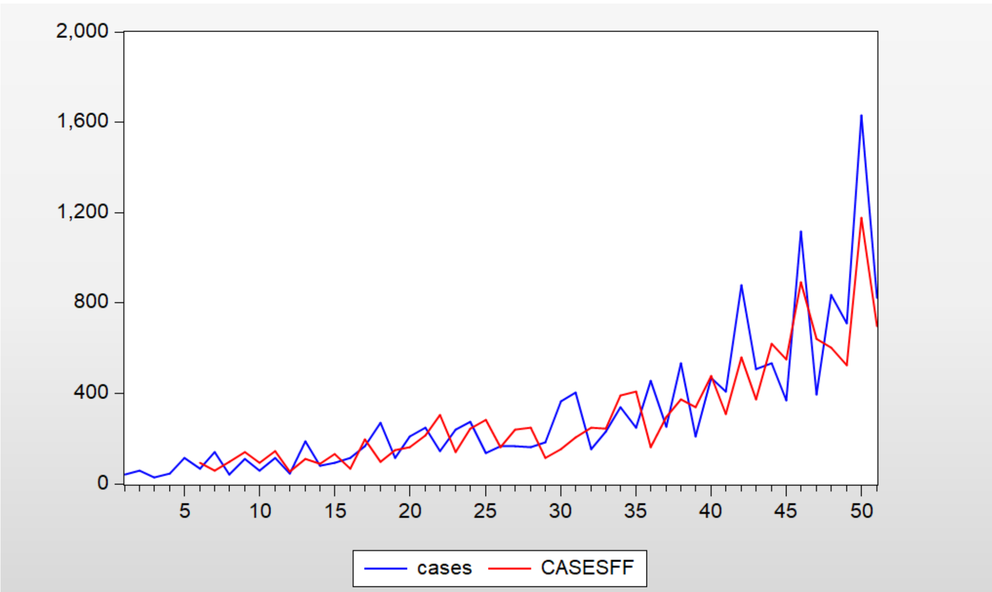
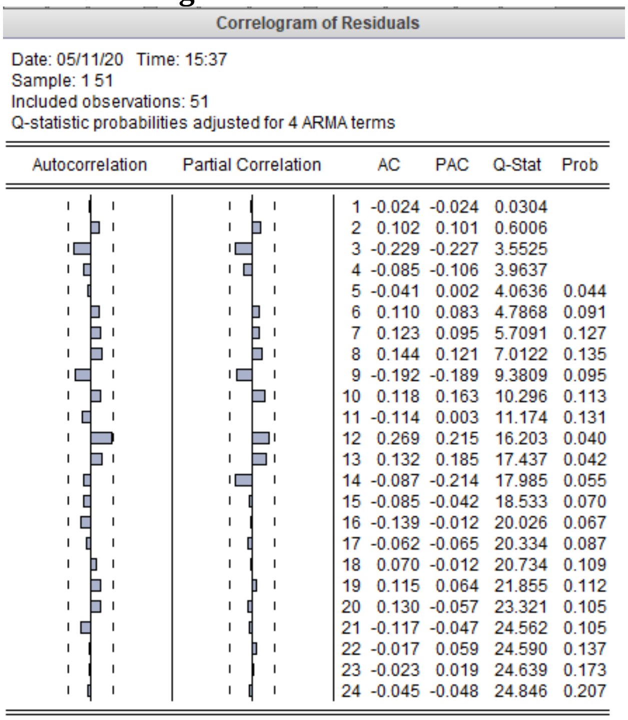


Figure 4: Actual and fitted graph for the confirmed cases data.

Residual Diagnostics


Correlogram of Residuals

Date: 05/11/20 Time: 15:37
Sample: 1 51
Included observations: 51
Q-statistic probabilities adjusted for 4 ARMA terms

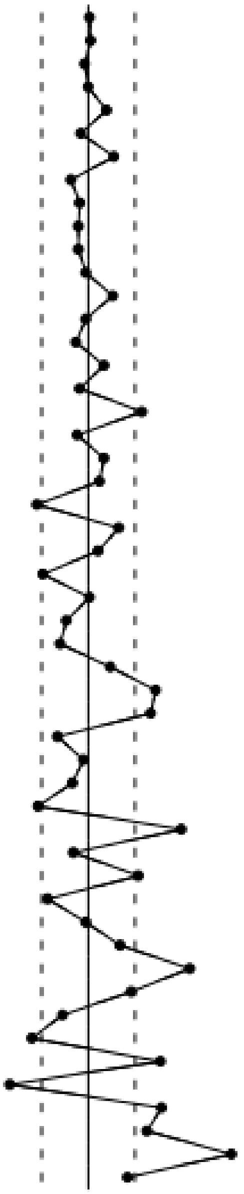
	AC	PAC	Q-Stat	Prob
1	-0.024	-0.024	0.0304	
2	0.102	0.101	0.6006	
3	-0.229	-0.227	3.5525	
4	-0.085	-0.106	3.9637	
5	-0.041	0.002	4.0636	0.044
6	0.110	0.083	4.7868	0.091
7	0.123	0.095	5.7091	0.127
8	0.144	0.121	7.0122	0.135
9	-0.192	-0.189	9.3809	0.095
10	0.118	0.163	10.296	0.113
11	-0.114	0.003	11.174	0.131
12	0.269	0.215	16.203	0.040
13	0.132	0.185	17.437	0.042
14	-0.087	-0.214	17.985	0.055
15	-0.085	-0.042	18.533	0.070
16	-0.139	-0.012	20.026	0.067
17	-0.062	-0.065	20.334	0.087
18	0.070	-0.012	20.734	0.109
19	0.115	0.064	21.855	0.112
20	0.130	-0.057	23.321	0.105
21	-0.117	-0.047	24.562	0.105
22	-0.017	0.059	24.590	0.137
23	-0.023	0.019	24.639	0.173
24	-0.045	-0.048	24.846	0.207

Figure 5: Correlogram of residuals from ARIMA (5, 1, 1) showing no significant lag spike.

Table 4: Actual, Fitted, and Residuals of the model.

obs	Actual	Fitted	Residual
1	43.0000	37.8189	5.18113
2	59.0000	50.8647	8.13527
3	30.0000	40.7764	-10.7764
4	44.0000	43.2616	0.73842
5	115.000	55.2506	59.7494
6	65.0000	88.9889	-23.9889
7	142.000	61.9138	80.0862
8	41.0000	94.5936	-53.5936
9	112.000	138.210	-26.2101
10	59.0000	90.5579	-31.5579
11	114.000	145.125	-31.1246
12	47.0000	54.9232	-7.92315
13	190.000	110.799	79.2007
14	80.0000	86.8957	-6.89567
15	91.0000	130.004	-39.0042
16	116.000	65.8642	50.1358
17	166.000	194.388	-28.3879
18	269.000	97.5628	171.437
19	114.000	148.500	-34.4997
20	210.000	160.763	49.2372
21	249.000	213.627	35.3728
22	144.000	306.014	-162.014
23	238.000	140.017	97.9831
24	273.000	241.968	31.0317
25	138.000	280.984	-142.984
26	166.000	160.263	5.73660
27	167.000	237.764	-70.7637
28	160.000	248.097	-88.0969
29	184.000	115.699	68.3011
30	367.000	154.481	212.519
31	403.000	206.732	196.268
32	153.000	249.122	-96.1217
33	231.000	245.636	-14.6357
34	339.000	390.854	-51.8543
35	247.000	406.525	-159.525
36	456.000	163.155	292.845
37	252.000	297.940	-45.9400
38	532.000	374.488	157.512
39	208.000	337.752	-129.752
40	467.000	476.025	-9.02530
41	407.000	306.945	100.055
42	880.000	558.768	321.232
43	508.000	373.028	134.972
44	535.000	617.832	-82.8319
45	371.000	549.172	-178.172
46	1117.00	890.120	226.880
47	394.000	640.976	-246.976
48	835.000	602.393	232.607
49	711.000	525.364	185.636
50	1629.00	1177.49	451.514
51	823.000	698.202	124.798

Residual Plot



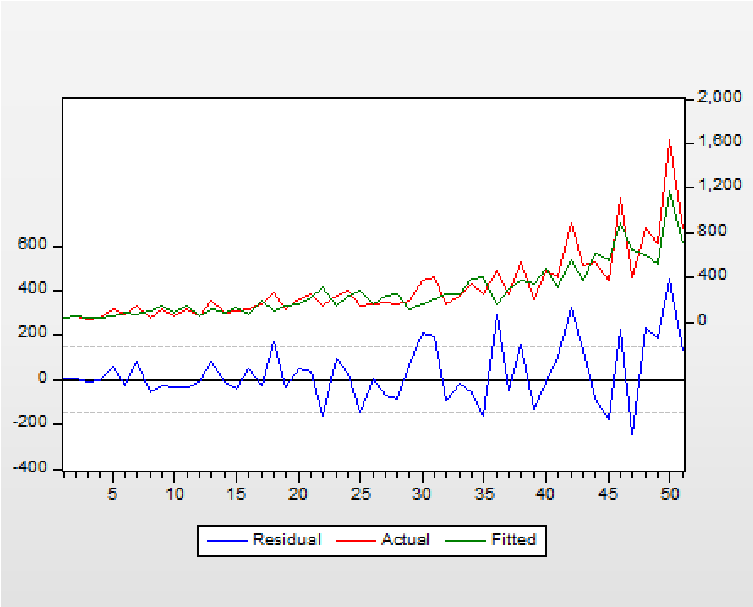


Figure 6: Actual, Fitted, and Residual plot of the model.

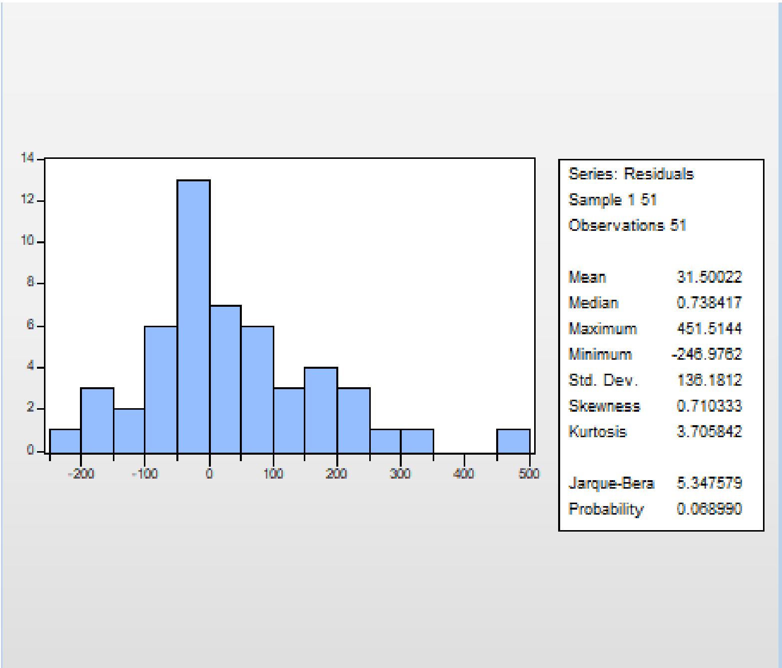


Figure 7: Histogram: normality test of residual for fitted confirmed cases data.

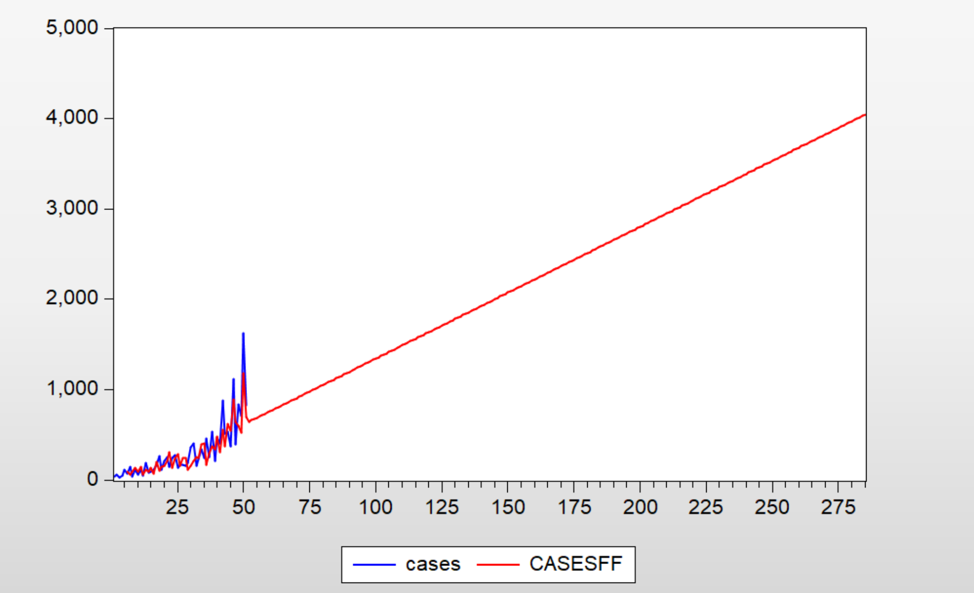


Figure 8: Plot of actual and forecasted values for confirmed cases showing an upward trend over the next 7 months.

5. Conclusion

Critical investigation into the rate of spread of COVID-19 pandemic has shown that, that the daily confirmed cases of the disease tends to follow an upward trend. This paper aimed to developing a suitable ARIMA model which can be used to fit a most appropriate model to statistically forecast the actual number of confirmed cases of COVID-19 recorded in ECOWAS. An adequate subset ARIMA (5, 1, 1) model is fitted to the data. A forecast of 235 days from 11th May, 2020 to 31th December, 2020, was carried out and we discovered that, the COVID-19 daily confirmed cases may likely incline over the next six months.

We therefore recommend that further studies should be carried out to understand and model the mortality rate as well as survival rate of COVID-19 in AFRICA and the world at large, with respect to age, sex, geographical area etc.

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Appendix 1: Sum of daily confirmed cases of COVID-19 In ECOWAS.

S/N	DATE	Total Confirmed Cases of COVID-19 in ECOWAS
1	3/21/2020	43
2	3/22/2020	59
3	3/23/2020	30
4	3/24/2020	44
5	3/25/2020	115
6	3/26/2020	65
7	3/27/2020	142
8	3/28/2020	41
9	3/29/2020	112
10	3/30/2020	59
11	3/31/2020	114
12	4/1/2020	47
13	4/2/2020	190
14	4/3/2020	80
15	4/4/2020	91
16	4/5/2020	116
17	4/6/2020	166
18	4/7/2020	269
19	4/8/2020	114
20	4/9/2020	210
21	4/10/2020	249
22	4/11/2020	144
23	4/12/2020	238
24	4/13/2020	273
25	4/14/2020	138

S/N	DATE	Total Confirmed Cases of COVID-19 in ECOWAS
26	4/15/2020	166
27	4/16/2020	167
28	4/17/2020	160
29	4/18/2020	184
30	4/19/2020	367
31	4/20/2020	403
32	4/21/2020	153
33	4/22/2020	231
34	4/23/2020	339
35	4/24/2020	247
36	4/25/2020	456
37	4/26/2020	252
38	4/27/2020	532
39	4/28/2020	208
40	4/29/2020	467
41	4/30/2020	407
42	5/1/2020	880
43	5/2/2020	508
44	5/3/2020	535
45	5/4/2020	371
46	5/5/2020	1117
47	5/6/2020	394
48	5/7/2020	835
49	5/8/2020	711
50	5/9/2020	1629
51	5/10/2020	823

Appendix 2: Sum of daily forecasted confirmed cases of COVID-19 in ECOWAS.

S/N	DATE	Forecasted Total Confirmed Cases of COVID-19 in ECOWAS	S/N	DATE	Forecasted Total Confirmed Cases of COVID-19 in ECOWAS
1	5/11/2020	644	39	6/18/2020	1199
2	5/12/2020	659	40	6/19/2020	1213
3	5/13/2020	673	41	6/20/2020	1228
4	5/16/2020	688	42	6/21/2020	1242
5	5/15/2020	703	43	6/22/2020	1257
6	5/16/2020	717	44	6/23/2020	1272
7	5/17/2020	732	45	6/24/2020	1286
8	5/18/2020	746	46	6/25/2020	1301
9	5/19/2020	761	47	6/26/2020	1315
10	5/20/2020	775	48	6/27/2020	1330
11	5/21/2020	790	49	6/28/2020	1345
12	5/22/2020	805	50	6/29/2020	1359
13	5/23/2020	819	51	6/30/2020	1374
14	5/24/2020	834	52	7/1/2020	1388
15	5/25/2020	848	53	7/2/2020	1403
16	5/26/2020	863	54	7/3/2020	1418
17	5/27/2020	878	55	7/4/2020	1432
18	5/28/2020	892	56	7/5/2020	1447
19	5/29/2020	907	57	7/6/2020	1461
20	5/30/2020	921	58	7/7/2020	1476
21	5/31/2020	936	59	7/8/2020	1491
22	6/1/2020	951	60	7/9/2020	1505
23	6/2/2020	965	61	7/10/2020	1520
24	6/3/2020	980	62	7/11/2020	1534
25	6/4/2020	994	63	7/12/2020	1549
26	5/5/2020	1009	64	7/13/2020	1563
27	6/6/2020	1024	65	7/14/2020	1578
28	6/7/2020	1038	66	7/15/2020	1593
29	6/8/2020	1053	67	7/16/2020	1607
30	6/9/2020	1067	68	7/17/2020	1622
31	6/10/2020	1082	69	7/18/2020	1636
32	6/11/2020	1097	70	7/19/2020	1651
33	6/12/2020	1111	71	7/20/2020	1666
34	6/13/2020	1126	72	7/21/2020	1680
35	6/14/2020	1140	73	7/22/2020	1695
36	6/15/2020	1155	74	7/23/2020	1709
37	6/16/2020	1169	75	7/24/2020	1724
38	6/17/2020	1184	76	7/25/2020	1739
S/N	DATE	Forecasted Total Confirmed Cases of	S/N	DATE	Forecasted Total Confirmed Cases

		COVID-19 in ECOWAS
77	7/26/2020	1753
78	7/27/2020	1768
79	7/28/2020	1782
80	7/29/2020	1797
81	7/31/2020	1826
82	8/1/2020	1841
83	8/2/2020	1855
84	8/3/2020	1870
85	8/4/2020	1885
86	8/5/2020	1899
87	8/6/2020	1914
88	8/7/2020	1928
89	8/8/2020	1943
90	8/9/2020	1957
91	8/10/2020	1972
92	8/11/2020	1987
93	8/12/2020	2001
94	8/13/2020	2016
95	8/14/2020	2030
96	8/15/2020	2045
97	8/16/2020	2060
98	8/17/2020	2074
99	8/18/2020	2089
100	8/19/2020	2103
101	8/20/2020	2118
102	8/21/2020	2133
103	8/22/2020	2147
104	8/23/2020	2162
105	8/24/2020	2176
106	8/25/2020	2191
107	8/26/2020	2206
108	8/27/2020	2220
109	8/28/2020	2235
110	8/29/2020	2249
111	8/30/2020	2264
112	8/31/2020	2278
113	9/1/2020	2293
114	9/2/2020	2308

		of COVID-19 in ECOWAS
115	9/3/2020	2322
116	9/4/2020	2337
117	9/5/2020	2351
118	9/6/2020	2366
119	9/7/2020	2381
120	9/8/2020	2395
121	9/9/2020	2410
122	9/10/2020	2424
123	9/11/2020	2439
124	9/12/2020	2454
125	9/13/2020	2468
126	9/14/2020	2483
127	9/15/2020	2497
128	9/16/2020	2512
129	9/17/2020	2527
130	9/18/2020	2541
131	9/19/2020	2556
132	9/20/2020	2570
133	9/21/2020	2585
134	9/22/2020	2600
135	9/23/2020	2614
136	9/24/2020	2629
137	9/25/2020	2643
138	9/26/2020	2658
139	9/27/2020	2672
140	9/28/2020	2687
141	9/29/2020	2702
142	9/30/2020	2716
143	10/1/2020	2731
144	10/2/2020	2745
145	10/3/2020	2760
146	10/10/2020	2775
147	10/5/2020	2789
148	10/6/2020	2804
149	10/7/2020	2818
150	10/8/2020	2833
151	10/9/2020	2848
152	10/10/2020	2862

S/N	DATE	Forecasted Total Confirmed Cases of COVID-19 in ECOWAS
153	10/11/2020	2877
154	10/12/2020	2891
155	10/13/2020	2906
156	10/14/2020	2921
157	10/15/2020	2935
158	10/16/2020	2950
159	10/17/2020	2964
160	10/18/2020	2979
161	10/19/2020	2994
162	10/20/2020	3008
163	10/21/2020	3023
164	10/22/2020	3037
165	10/23/2020	3052
166	10/24/2020	3066
167	10/25/2020	3081
168	10/26/2020	3096
169	10/27/2020	3110
170	10/28/2020	3125
171	10/29/2020	3139
172	10/30/2020	3154
173	10/31/2020	3169
174	11/1/2020	3183
175	11/2/2020	3198
176	11/3/2020	3212
177	11/4/2020	3227
178	11/5/2020	3242
179	11/6/2020	3256
180	11/7/2020	3271
181	11/8/2020	3285
182	11/9/2020	3300
183	11/10/2020	3315
184	11/11/2020	3329
185	11/12/2020	3344
186	11/13/2020	3358
187	11/14/2020	3373
188	11/15/2020	3388
189	11/16/2020	3402
190	11/17/2020	3417

S/N	DATE	Forecasted Total Confirmed Cases of COVID-19 in ECOWAS
191	11/18/2020	3431
192	11/19/2020	3446
193	11/20/2020	3460
194	11/21/2020	3475
195	11/22/2020	3490
196	11/23/2020	3504
197	11/24/2020	3519
198	11/25/2020	3533
199	11/26/2020	3548
200	11/27/2020	3563
201	11/28/2020	3577
202	11/29/2020	3592
203	11/30/2020	3606
204	12/1/2020	3621
205	12/2/2020	3636
206	12/3/2020	3650
207	12/4/2020	3665
208	12/5/2020	3679
209	12/6/2020	3694
210	12/7/2020	3709
211	12/8/2020	3723
212	12/9/2020	3738
213	12/10/2020	3752
214	12/11/2020	3767
215	12/12/2020	3782
216	12/13/2020	3796
217	12/14/2020	3811
218	12/15/2020	3825
219	12/16/2020	3840
220	12/17/2020	3854
221	12/18/2020	3869
222	12/19/2020	3884
223	12/20/2020	3898
224	12/21/2020	3913
225	12/22/2020	3927
226	12/23/2020	3942
227	12/24/2020	3957
228	12/25/2020	3971

S/N	DATE	Forecasted Total Confirmed Cases of COVID-19 in ECOWAS
229	12/26/2020	3986
230	12/27/2020	4000
231	12/28/2020	4015
232	12/29/2020	4030
233	12/30/2020	4044
234	12/31/2020	4059
TOTAL FORECASTED CASES FOR THE STUDY PERIOD		497385
AVERAGE DAILY FORECASTED CASES FOR THE STUDY PERIOD		2512.045455